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Description

The present invention relates to new and improved absorbent products and, more particularly, to new and improved thin absorbent composites incorporating superabsorbent materials.

Disposable absorbent products have been known for some time, including such products as disposable diapers, sanitary napkins, wound dressings, bandages and incontinence pads. These products incorporate an absorbent batt which is used to absorb and hold or contain body fluids. Initially, in many of these products, especially diapers and sanitary napkins, the absorbent batt comprised what is termed "wadding" or plies of tissue. The wadding was disposed between an impermeable backing and a permeable facing and the plies of tissue were used to absorb and, hopefully, contain the liquid within the product. A diaper which utilizes such an absorbent batt is disclosed in U.S. Reissue Patent No. 26,151.

The wadding type of batt was replaced, for the most part, by an improved absorbent batt which comprises what is termed "fluffed wood pulp fibers". This absorbent batt comprises a layer of individualized wood pulp fibers with the layer having substantial thickness. A diaper which incorporates such a fluffed wood pulp absorbent batt is described in US—A—2,788,003. This diaper had improved absorbent capacity and somewhat better containment than a diaper using a wadding layer. Also the fluffed wood pulp layer is quite soft, flexible and conformable and hence produces an improved diaper over diapers using wadding as the absorbent layer.

Though the fluffed wood pulp absorbent batts have improved capacity, the efficiency with which the capacity is used in a diaper or sanitary napkin is poor. The reason for this is that the fluid to be absorbed is generally deposited in a localized area within the absorbent batt and the ability for the fluid to move along the plane of the batt is poor. The fluid follows the path of least resistance and consequently moves to the closest edge of the batt where it generally is no longer contained and the product leaks.

US—A—3,017,304 discloses an absorbent product which incorporates in the product a densified, paper-like layer. This paper-like layer acts as a wick, i.e. liquid which is placed on the layer tends to move rapidly along the plane of the layer. When incorporated in combination with fluffed wood pulp fiber, the resultant product uses the absorbent capacity of the fluffed wood pulp much more efficiently. Diapers which incorporate this paper-like layer combined with fluffed wood pulp are disclosed and described in US—A—3,612,055 and US—A—3,938,522. This concept of combining a wicking or capillary skin or layer with fluffed wood pulp fibers has gained wide acceptance in many absorbent products including disposable diapers and sanitary napkins. Even though these products make much greater use of the capacity of the absorbent batt, they still do not totally contain the absorbed liquid. It is probable that these products will leak before the full capacity of the batt is used for absorption. This is especially true if pressure is placed on the batt while wet, for example a baby sitting down on a previously wetted diaper will very often cause the batt to leak.

Recently, elastic leg diapers or stretch diapers have been introduced into the marketplace. Though these diapers provide no better absorbent batt than flat diapers or the prior art diapers, they have indicated improved containment of liquid. Such diapers are disclosed and described in US—A—3,860,003, US—A—4,050,462, and US—A—4,324,245. Though the containment features are better than the prior art products, the elasticized products fit more tightly permitting less air circulation. Frequently, this can become irritating to the skin and the tighter the elastic or the more close fitting the diaper, the greater the irritation. This is especially true adjacent the area where the elastic leg portion of the product contacts the wearer.

A number of years ago "superabsorbent materials", i.e. materials which will absorb many times their weight of liquid, were developed. Since the development of such materials, people have been trying to incorporate them in absorbent products such as diapers and sanitary napkins to enhance the absorptive performance of these products. Theoretically, a minimum amount of superabsorbent incorporated in a product would make that product perform as well or better than the prior art products. Perhaps one of the first products to incorporate such a superabsorbent material in a disposable diaper is disclosed in US—A—3,670,731. This patent discloses an absorbent dressing comprising an absorbent layer sandwiched between a permeable facing and an impermeable backing sheet. The absorbent layer contains water insoluble cross-linked hydrocolloid polymer as the superabsorbent material.

Even though superabsorbent materials have been available for some time, they have not gained wide acceptance in absorbent products such as disposable diapers and sanitary napkins. A primary reason for this lack of acceptance of the superabsorbents is failure to develop a product capable of economically utilizing the highly increased absorptive capacity of the superabsorbent material. In order to economically utilize a superabsorbent, the liquid being absorbed must be transported to the superabsorbent material. In other words, the superabsorbent material must be placed in contact with the liquid. Furthermore, as the superabsorbent material absorbs the liquid, it must be allowed to swell. If the superabsorbent is prevented from swelling, it will cease absorbing liquid. Hence if the superabsorbent material is to function in diapers and sanitary napkins wherein the liquid to be absorbed is placed in a small void area, the structure of the absorbent layer containing super-

absorbent materials appears to be critical. Over the years a number of techniques have been disclosed in an attempt to provide structures which make efficient use of the superabsorbent material. Such products are disclosed in US—A—4,103,062, US—A—4,102,340, and US—A—4,235,237. In addition, methods for incorporating superabsorbents into suitable layers or suitable configurations which can be placed in an absorbent product are disclosed in US—A—4,186,165, US—A—4,340,057 and US—A—4,364,992. To date, none of these products has met with any substantial commercial success.

The present invention provides a new and improved absorbent composite which utilizes a substantial portion of the absorptive capacity of superabsorbent materials. This new composite makes use of this capacity even though the liquid being absorbed is placed on the composite in a localized area. In addition and unexpectedly, when used in a diaper the new composite contains the liquid absorbed in the composite even without the use of elastic leg members in the product. Surprisingly, the new composite will retain absorbed liquid without leakage even when pressure is placed upon the product during use.

The present invention provides a disposable, absorbent, compressed composite as defined in claim 1. The absorbing layer is a fibrous web preferably of substantially high loft which upon dry compression followed by release of the compression substantially returns to its original thickness. The absorbing layer has superabsorbent distributed substantially throughout the layer preferably in the form of particles, globules, film pieces, granules or powder. The superabsorbent material is of a particle size range and is distributed in such a manner preferably as to minimize interference of one particle with another upon swelling of the superabsorbent material as it contacts the liquid. The wicking layer is comprised of hydrophilic fibers such as cellulosic fibers, rayon fibers or the like, or peat moss or other substances which upon closely spaced relationship promote the movement of liquid along the plane of the layer. The transition zone is comprised of a portion of the wicking layer and a portion of the absorbing layer in intimate contact resulting from compression of the absorbing layer and wicking layer after one layer is placed upon the other. In fact some portions of the wicking layer are in intimate contact with some of the superabsorbent material.

The present invention provides an absorbent compressed composite comprising: a first fibrous layer having a given thickness dimension in uncompressed form, superabsorbent material within said first layer and cooperating with the fibers of said first layer to retain said first layer in a compressed form with a thickness dimension less than said given thickness dimension; and a second layer discrete from but united to said first layer, said second layer having no superabsorbent material therewithin and being denser than said first layer prior to incorporation of the superabsorbent therein, to provide preferential wicking of liquid within said second layer prior to incorporation of the superabsorbent therein, whereby liquid wetted upon said composite in a given area is transported in said second layer away from said given area and distributed to portions of said first layer remote from said given area, said superabsorbent material upon swelling permitting said first fibrous layer to expand from said compressed form upon absorption of liquid in said superabsorbent material to thereby provide increased liquid holding capacity within said first layer.

The absorbent system of the present invention is comprised of at least two layers to form a thin, absorbent structure. One layer functions primarily as a liquid transport media, i.e., a wicking layer. The other layer functions as an absorbent reservoir to retain volumes of body fluids. This layer is referred to as the absorbing layer. The absorbing layer is preferably a low density, resilient, fibrous web consisting of randomly disposed, frictionally entangled fibers which result in a web having a dry bulk recovery of at least 30 percent, an initial dry bulk of at least 20 cc/gm and a weight less than 68 $g.m^{-2}$ (2 oz/yd^2). The fibrous web making up the absorbing layer is used to spacially distribute superabsorbent material so that upon exposure to an aqueous fluid, swelling occurs with minimal interference from adjacent superabsorbent material. The transporting or wicking layer is a high density structure made of particles preferably selected from the group consisting of cellulosic fibers, peat moss, rayon fibers or mixtures thereof. One layer is superimposed upon the other by air laying with or without vacuum, water casting, simple placement or the like. The two layers are compressed at a pressure adequate to collapse the total structure to promote intimate contact between the wicking layer and the absorbing layer. In fact, at least portions of some of the wicking layer extend into and become integral with the absorbing layer providing a transition zone wherein some of the particles come in contact with some of the superabsorbent material interspersed in the absorbing layer. Generally, the compression is carried out in the presence of a moisture content of at least about 10 percent by weight so that some of the superabsorbent is soft and tacky and upon compression holds the absorbing layer in a compressed state. When being used, the compressed composite product is exposed to a fluid including body fluids such as urine, menstrual fluid, or other fluids. Generally, the fluids are deposited in a localized area on one surface of the compressed composite product. The wicking layer immediately transports any excess fluid in any given area to other areas in the x, y plane of the layered structure. As fluid contacts the unwetted areas of the structure, the superabsorbent in intimate contact with the wicking layer begins to form a gel and soften. As softening occurs, the absorbing layer is gradually released from its compressed state and recovers

substantially its original low density nature due to the fibrous web resilience. This low density fibrous web provides storage areas for the liquid and the superabsorbent continues to swell with minimal interference from adjacent superabsorbent material. As the liquid front moves along the x, y plane, it triggers sequential release of the resilient structure to allow fluid migration in the z direction as well, i.e., in the direction of the thickness of the product.

Brief description of the drawings

Figure 1 is a perspective view illustrating one embodiment of the present invention;

Figure 2 is an enlarged cross-sectional view through lines 2—2 of Figure 1;

Figure 2A is an enlarged cross-sectional view through lines 2—2 of Figure 1 but after compression;

Figure 3 is a perspective view illustrating another embodiment of the present invention;

Figure 4 is a perspective view illustrating still another embodiment of the present invention;

Figure 5 is an enlarged cross-sectional view through lines 5—5 of Figure 4;

Figure 6 is a perspective view of a blank for a tampon embodying the present invention;

Figure 7 is a perspective view of a tampon made from the blank shown in Figure 6;

Figure 8 is a perspective view of another blank for a tampon embodying the present invention;

Figure 9 is a cross-sectional view of a tampon made from the blank of Figure 8; and

Figure 10 is a perspective view of a wipe illustrating another embodiment of the present invention.

Referring now to the drawings, Figure 1 represents a perspective view of an absorbent product of the present invention. The absorbent product 10 has a fibrous web as an absorbing layer 12. Interspersed and fixed in the absorbing layer is superabsorbent material 16. Immediately associated with the absorbing layer is the wicking layer 14. Some portions of the wicking layer 14 extend into and become integral with the absorbing layer 12 thus forming the transition zone 18. By "integral with" is meant in intimate contact with but not requiring physical or chemical bonding. The structure depicted in Figure 1 is in an uncompressed state for ease of illustration. Upon compression some of the portions in the wicking layer 14 will extend into and become integral with the fibers of the absorbing layer. These wicking layer portions consequently will also be in contact with the superabsorbent material. Generally at least 10 percent moisture is present when the structure is compressed under a pressure sufficient to compact the structure and cause the softened surface of the superabsorbent material to provide the necessary adhesion to the fibers of the absorbing layer so that the composite remains in a compacted state even when dry.

Figure 2 provides a cross-sectional view along line 2—2 of Figure 1 showing in detail the relationship of the layers of the absorbent product. The absorbing layer 12 is made from resilient fibers. The superabsorbent material 16 is interspersed and preferably fixed among the resilient fibers 23. The wicking layer 14 is comprised of portions 26 some of which extend into and become integral with the absorbing layer. The transition zone 18 contains the wicking layer portions 26 in contact with a portion of the absorbing layer 12 and its fibers 23 so as to be in intimate contact with some of the superabsorbent particles 16. Figure 2A depicts the structure of Figure 2 in a compressed state showing that the absorbing layer 12 has been substantially reduced in thickness and the wicking layer 14 has also been reduced in thickness but extends considerably into and becomes integral with the absorbing layer to form the transition zone 18. Although the superabsorbent particles 16 are closer to each other, there is still sufficient opportunity for liquid to pass between the particles and upon their softening and the reslient fibers of the absorbing layer are released to return the layer to its original low density form.

Referring now to Figure 3, a diaper 30 is depicted. A moisture-pervious facing such as a nonwoven fabric 31 provides the diaper surface. A moisture-impervious substance, such as polyethylene, forms the moisture-proof backing 32 of the diaper. This particular diaper structure 30 contains one complete compressed composite layer, 33, and two layers, 34 and 35, which are placed only in the front portion of the diaper at the end opposite the tape tabs 39, each layer being the absorbent structure shown in Figure 1, but in a compressed state. In order to seal the diaper in the margins, glue lines 38 are provided. To secure the diaper about the waist of the wearer, tape tabs 39 are provided. The diaper product 30 provides an exceptionally thin diaper which accepts liquid and rapidly transports it to all areas of the absorbent structures 33, 34, and 35. In producing a diaper in accordance with Figure 3, one or more layers of the absorbent structure may be used. Generally, the wicking layer is placed closest to the facing. However, when multiple composites are being used, the remaining composites may be placed with the wicking layer either toward the facing or the backing. Even using three layers of the absorbent structure of the present invention a diaper is provided having less thickness than a commercial fluff pulp diaper presently available.

Referring now to Figure 4, a sanitary napkin 40 is provided having a fabric overlay 42. Figure 5 is a cross sectional view along line 5—5 of Figure 4 showing the layer construction in the napkin depicted in Figure 4. The structure 40 has a moisture-permeable nonwoven fabric 42. Surrounding the sides and bottom area of the structure is a moisture-impermeable wrap 54. Immediately associated with the exterior wrap 42 in the fluid receiving area is an absorbent structure 55 with a wicking layer 56 in immediate contact with the exterior wrap. Thus, as the liquid enters the absorbent structure 55 through the

exterior wrap 42 it is immediately transported in the wicking layer 56. The liquid then migrates through the absorbing layer 57 and into the adjacent absorbing layer 59 of absorbent structure 53. As the liquid continues its progression throughout the entire structure 50, it proceeds to wicking layer 51 of absorbent structure 53 and is transported in the x, y plane along the moisture-impermeable wrap 54. The two compressed composite structures 53 and 55 provide a sanitary napkin of less than half the thickness of the conventional fibrous batt napkin.

Figure 6 depicts a blank 60 for manufacturing a tampon consisting of a single absorbent structure depicted in Figure 1 but in a compressed state. The surface 64 is the surface of the absorbing layer and is a nonwoven web of wet-resilient fibers having interspersed therein superabsorbent. The surface 62 is a layer of wood pulp fibers closely associated with the absorbing layer. The two layers are in a compressed state and provide a transition zone at the points of contact of the two layers. The blank 60 is rolled and shaped so as to form the tampon 70 depicted in Figure 7. The broken away portion of the drawing shows the absorbing layer 64 and the wicking layer 62. The transition zone lies at the contact points of the two layers.

In still another tampon structure depicted in Figure 8, a blank 80 is provided with a wicking layer 81, an absorbing layer 83, and another wicking layer 82 on the opposite surface of the absorbing layer. This structure provides two transition zones 85 and 86 upon compression. Superabsorbent materials 84 are interspersed and fixed in the absorbing layer 83. The tampon blank 80 is folded over and shaped to provide the tampon 90 in Figure 9. In Figure 9 the tampon is cut away to provide a cross-sectional view showing the two wicking layers 81 and 82 with the absorbing layer 83 sandwiched in between. The absorbing layer contains the superabsorbent material 84. Transition zones 85 and 86 provide the necessary contact of the wicking layer with the absorbing layer superabsorbent material.

Figure 10 depicts a wipe 100 wherein a polypropylene nonwoven fabric 102 forms a substrate. Affixed to the substrate 102 is a compressed composite 104 with its absorbing layer superimposed on the substrate 102 and the wicking layer forming the opposing surface.

These and other products such as incontinence pads and wound dressings may be made from the absorbent structure depicted in Figure 1 but in a compressed state.

The absorbing layer is a fibrous web which is of substantially high loft and which upon dry compression, followed by release, has a tendency to return substantially to its original thickness. For instance, fibrous webs formed from synthetic stable fibers, such as polyethylene, polypropylene, polyester, nylon, bicomponent fibers are particularly desirable. However, cellulosic fibers, such as rayon, may be used. Generally the fibers are airlaid to form a web which is then stabilized if needed. Stabilization may be achieved by heat-through bonding, adhesive bonding or point embossing with heat or adhesive. The stabilizing process is selected according to the fibers used and the process used to form the web. Suitable procedures for forming a web include carding, wet laying, air laying, combinations of these and other suitable known techniques. The fibrous web preferably has a dry bulk recovery of at least 30 percent, an initial dry bulk of at least 20 cc/g and a weight of less than 68 $g.m^{-2}$ (2 oz/yd^2).

In one embodiment, a blend of staple polyester fibers with a minor portion of fusible fibers are air-laid to form a web. The web is subsequently lightly bonded by passing hot air through the fibers making the fusible fibers tacky so as to stick to each other and the staple fibers to provide some degree of integrity to the web structure.

The superabsorbent material present in an intermittently dispersed form in the absorbing layer is generally a water-insoluble but water-swellable polymeric substance capable of absorbing water in an amount which is at least 10 times the weight of the substance in its dry form. The superabsorbent material is in the form of particles which may be in the shape of fibers, spheres, bits of film or globules, or may be applied in the form of a liquid monomer solution which is subsequently polymerized. Generally, the polymerized monomer solution provides globules and bits of film-like particles in the structure.

In one type of superabsorbent material, the particles or fibers may be described chemically as having a backbone of natural or synthetic polymers with hydrophilic groups or polymers containing hydrophilic groups being chemically bonded to the backbone or in intimate admixture therewith. Included in this class of materials are such modified natural and regenerated polymers as polysaccharides including, for example, cellulose and starch and regenerated cellulose which are modified by being carboxyalkylated, phosphonoalkylated, suphoalkylated or phosphorylated to render them highly hydrophilic. Such modified polymers may also be cross-linked to improve their water-insolubility.

These same polysaccharides may also serve, for example, as the backbone onto which other polymer moieties may be bonded by graft copolymerization techniques. Such grafted polysaccharides and their method of manufactured are described in US—A—4,105,033 and may be described as polysaccharide chains having grafted thereon a hydrophilic chain of the general formula

$$\left[\begin{array}{l}(CH_2)_q\text{—}CR^1\\ \qquad\quad |\\ \qquad\ C{=}O\\ \qquad\quad |\\ \qquad\quad A\end{array}\right]_r \qquad \left[\begin{array}{l}(CH_2)_p\text{—}CR^2\\ \qquad\quad |\\ \qquad\ C{=}O\\ \qquad\quad |\\ \qquad\quad B\end{array}\right]_s$$

wherein A and B are —OR^3, —O (alkali metal), —$OHNH_3$, or —NH_2, wherein R^1, R^2 and R^3 of hydrogen or alkyl having 1 to 4 or more carbon atoms, wherein r is an integer having a value of 0 to 5000 or more, s is an integer having a value of 0 to 5000 or more, r plus s is at least 500, p is an integer having a value of zero or 1 and q is an integer having a value of 1 to 4. The preferred hydrophilic chains are hydrolyzed polyacrylonitrile chains and copolymers of polyacrylamide and polysodium acrylate.

In addition to modified natural and regenerated polymers, the hydrocolloid particle component may comprise wholly synthetic hydrophilic particles. Examples of those now known in the art are polyacrylonitrile fibers which may be modified by grafting moieties thereon such as polyvinyl alcohol chains, polyvinyl alcohol itself, hydrophilic polyurethane, poly(alkyl phosphonates), partially hydrolyzed polyacrylamides (e.g., poly(N - N - dimethyl acrylamide), sulfonated polystyrene, or a class of poly(alkylene oxide). These highly hydrophilic synthetic polymers may be modified by other chemical treatments such as cross-linking or hydrolysis. Further examples known in the art are the non-ionic hydrophilic polymers such as polyoxyethylene, polyoxypropylene and mixtures thereof which have been suitably cross-linked, either chemically or by irradiation. Still another more recent type is a derivative of isobutylene - maleic anhydride copolymer.

Hydrophilic polymers formed from water-soluble acrylate monomers, such as sodium, potassium, ammonium (or combination of cations), acrylate, may be placed on the absorbing layer by spraying or otherwise placing a solution thereon followed by polymerization and cross-linking, for example, by irradiation.

In addition, naturally occurring materials such as gums, may be used. For instance, guar gum is suitable.

The superabsorbent material is combined with the fibrous web by any means suitable to distribute the superabsorbent material therein trying to minimize interference by one superabsorbent entity with another upon the swelling of the first. If the superabsorbent material is a powder it may be sprinkled onto the fibrous web either in dry form or the web may be moistened. If the superabsorbent is in granular form it may be desirable to slightly moisten the superabsorbent before placing it in contact with the web. The superabsorbent material will contain particles which range in size from about 0.005 mm in diameter to globules that are continuous along fibers for a distance up to several inches.

Another method of placing the superabsorbent in the web is spraying a monomer solution on the web or saturating the web with a monomer solution followed by polymerization of the monomer. One typical way to polymerize the monomer is by use of irradiation. It is desirable to place the superabsorbent somewhat evenly throughout the fibrous web. However, even if the superabsorbent is powderlike and in the form of a layer, it tends to function better than such a layer has in previously known products.

Any superabsorbent which absorbs large amounts of liquids is suitable for use in the absorbing layer of the present invention.

The wicking layer is comprised of hydrophilic fibers, such as rayon fibers, cellulosic fibers, or peat moss, or mixtures thereof. The cellulosic fibers include wood pulp fibers and cotton linters. The wood pulp fibers generally are those that are used to form the fluff or fibrous batt layer in conventional absorbent products such as disposable diapers, sanitary napkins, etc. Other cellulosic fibers that might be used are rayon fibers, flax, hemp, jute, ramie and cotton. The fibers or peat moss or mixtures thereof are placed in such a way as to form a layer in which the particles are close to one another so as to promote wicking of liquid in the plane of the layer.

The wicking layer can be preformed and placed next to the absorbing layer before compression or the wicking layer particles can be air-laid or wet-laid on to the absorbing layer before compression.

The transition zone is a region formed at the junction of the absorbing layer and the wicking layer. Some of the particles, e.g., fibers, of the wicking layer extend into and become integral with the absorbing layer. The region in which the majority of the extending particles lie is identified as the transition zone. In the transition zone, there is a composite of absorbing layer fibers, superabsorbent material, and wicking layer particles. The wicking layer particles which have extended into the absorbing layer are in intimate contact with some of the superabsorbent material of the absorbing layer. This permits the liquid to commence its migration in the z direction to reach the superabsorbent material. As the liquid progresses in the z direction, the superabsorbent material becomes soft and releases the absorbing layer fibers which permit the absorbing layer to return substantially to its uncompressed thickness. As the absorbing layer returns to its uncompressed thickness, larger void areas are provided for storage of the liquid and for increased swelling of the superabsorbent material as it absorbs the liquid residing in the void areas. The absorbing layer tends to return to its uncompressed thickness, probably because of both the resiliency of the fibers and the swelling of the superabsorbent material.

In order for the absorbing layer fibrous web to provide the necessary medium for absorbing liquid, it is preferred that the fibrous web has a dry bulk recovery of at least 30 percent, (preferably 60 percent) an initial dry bulk of at least about 20 cc/gm, and a weight of less than 68 $g.m^{-2}$ (2 oz/yd^2). The initial dry bulk is the area times thickness of the layer under a load of 0.7 g per square centimetre (0.01 pounds per square inch) calculated in cubic centimeters. This value is divided by the weight in grams in order to provide the measurement in cubic centimeters per gram.

The dry bulk recovery is obtained by subjecting the web to a load of 12.1 kPa (1.75 psi) for five minutes, removing the load and allowing the web to rest for one minute, subjecting the web to a load of 0.7 g.cm^{-2} (0.01 psi) for one minute and then measuring the final dry bulk while under the 0.7 g.cm^{-2} (0.01 psi) load. The dry bulk recovery is the final bulk divided by the initial bulk expressed in percent. It is preferred that if the fibrous web provide a dry bulk recovery of at least 30 percent an initial dry bulk of at least 20 cc/gm, with a web weight of less than 68 g.m^{-2} (2 oz/yd^2). When the fibrous web meets these requirements, it can retain superabsorbent material up to at least 1,500 percent of the dry basis weight of the web. It is preferable that the web contain 200 percent to 1,500 percent by weight, dry basis, superabsorbent to the dry basis weight of the web. Most preferred is a range from about 400 percent to about 1,200 percent.

Examples of methods of preparing the absorbent product of the present invention are as follows. These examples are not intended to be limiting in any way and extensions and modifications thereof without departure from the scope of the invention will become apparent from these examples.

Example 1

An absorbing layer is formed of polyester fibers by dry laying the fibers, i.e., by air laying or carding to form a web. Specifically, the polyester fibers contain a minor portion of fusible fibers which soften at a lower temperature than the rest of the fibers. The web is heat bonded by passing air at a temperature of 177°C (350°F) through the web for about 10 second. The resulting web is 25 grams per square meter, basis weight. The specific polyester fibers used are identified as Type 99 Hollofil fibers manufactured and sold by E. I. Dupont Company. The fibrous web is placed on top of a sheet of wet-formed chemically delignified wood pulp fibers, the fibers being identified as RayFloc JLD manufactured by ITT Rayonair having a basis weight of 50 grams per square meter. A powder superabsorbent polymer is uniformly sprinkled onto and into the nonwoven fiber polyester structure at a concentration of 200 grams per square meter. The particular superabsorbent used is identified as Permasorb 10 manufactured by National Starch and Chemical Corporation. The structure is sprayed with a mist of water on the polyester side and then subjected to a compression force of 4.4 MPa (640 psi) for 30 seconds. On release of the pressure the structure remains compressed and is available to function as an absorbent product described in this invention.

Example 2

Using the same polyester fibrous web formed in Example 1, the web is coated by saturating it with a solution of sodium acrylate, removing the excess solution and irradiating the web to polymerize and crosslink the monomer and form polysodium acrylate (PSA) affixed to the polyester fiber. Two hundred grams/m^2 of PSA is present in the substrate. This is equivalent to 800% dry-add-on.

This coated substrate is passed beneath a hammer mill that deposits chemically treated wood pulp fibers onto the polyester web. Vacuum is applied under the polyester web so as to cause some of the pulp fibers to at least partially migrate into the polyester web and become integral therewith. The major portion of the wood pulp fibers will reside on the surface providing a layer containing wood pulp fibers of 50 gms/m^2. The surface of the pulp layer is sprayed with water so that the total moisture content of the pulp is 10 percent by weight. This structure is compressed at a level of 4.4 MPa (640 psi) for 30 seconds. Upon release of pressure the pulp has formed into a high density layer with a capillary size suitable for liquid wicking and the resilient fiber layer remains compressed. Upon use of this structure when a significant amount of liquid contacts the surface and migration of the liquid into the product takes place, the superabsorbent become soft and releases the resilient fibers so that the thickness of the absorbent structure increases markedly. This provides an area for storage of liquid wherein the capillary size is large.

Example 3

The same polyester web is treated with a wood pulp fiber-water slurry which is drained through the polyester fiber web so that a pulp deposit of 50 grams per square meter is formed on one side of the polyester web. The two layered sheet is dried. Onto the polyester web side of the sheet is sprayed the same monomer solution as in Example 2, so that practically no monomer solution contacts the wood pulp fiber layer. As before, the sample is coated and treated three times providing 800% dry-add-on of PSA. The resulting structure at a moisture content of approximately 50 percent by weight is compressed at a level of 4.4 MPa (640 psi) for 30 seconds. Upon release of the pressure the structure remains compressed and is ready for use as taught hereinbefore.

The moisture level of the two layers prior to compression preferably is sufficient to make the exterior surface of the superabsorbent tacky so as to provide a temporary bonding of the wet resilient fibers under compression. Thus, the compressed composite structure remains compressed until it is in contact with sufficient liquid for the superabsorbent to begin swelling and to thereby release the bonds formed with the resilient fibers.

The amount of superabsorbent added to the absorbing layer should not exceed the volumetric displaced afforded by the subsequent compression.

The structure generally is compressed sufficiently to reduce the thickness of the structure by at least 50 percent and the pressure is sufficient to

cause the composite to remain compact after the pressure is released. Compression should not be high enough to substantially crimp or crease the fibers in the absorbing layer.

Other methods for preparing the absorbent product of the present invention may be used.

From the foregoing it will be observed that numerous variations and modifications may be effected without departing from the scope of this invention.

Claims

1. An absorbent compressed composite comprising:

a first fibrous layer (12) having a given thickness dimension in uncompressed form;

a water-insoluble but water-swellable polymeric superabsorbent material (16) which is capable of absorbing water in an amount which is at least 10 times the weight of the material in its dry form, within said first layer (12) and which holds said first layer (12) in a compressed form with a thickness dimension less than said given thickness dimension; and

a second layer (14) on said first layer (12), with parts of said second layer (14) extending into and becoming spacially integral with said first layer (12) to provide a transition zone;

said second layer (14) having no superabsorbent material therewithin and being denser than said first layer (12) prior to the incorporation of the superabsorbent material (16) therein

whereby liquid wetted on said composite wicks faster along the surface of said second layer (14) than along the surface of said first layer (12), and liquid wetted upon said composite (10) in a given area is transported in said second layer (14) away from said given area and distributed to portions of said first layer (12) remote from said given area,

said superabsorbent material (16) upon swelling releasing its hold on said first layer, thus permitting said first layer (12) to expand from said compressed form upon absorption of liquid in said superabsorbent material (16).

2. The compressed composite of claim 1, wherein:

the first layer (12) has a dry bulk recovery of at least 30%, an initial dry bulk of at least 20 cc/g, and a weight of less than 68 $g.m^{-2}$ (2 $oz.yd^{-2}$);

the second layer (14) comprises particles consisting of cellulosic fibers, peat moss, rayon fibers or mixtures thereof; and

the amount of superabsorbent material (16) present is at least 200% dry weight basis (based on said first web (12) dry weight basis).

3. The compressed composite of claim 1 or claim 2, wherein the superabsorbent material (16) is present as a plurality of particles or globules.

4. The compressed composite of any one of claims 1 to 3, wherein the superabsorbent material (16) is present in an amount of 200 to 1500% dry weight basis.

5. The compressed composite of claim 4 wherein said superabsorbent material (16) is present in an amount from 400 percent to 1,200 percent dry weight basis.

6. The compressed composite of any one of claims 1 to 5, wherein said first layer (12) is a nonwoven fibrous web.

7. The compressed composite of claim 6, wherein the web (12) is of synthetic staple fibers.

8. The compressed composite of claim 6 or claim 7 wherein the nonwoven web (12) is of polyester fibers.

9. The compressed composite of any one of claims 1 to 8 wherein said second layer (14) is chemically delignified wood pulp fibers.

10. The compressed composite of any one of claims 1 to 8 wherein said second layer (14) is peat moss.

11. The absorbent composite of any one of claims 1 to 8 wherein said second layer (14) is rayon fibers.

12. A disposable diaper (30) containing an absorbent pad (33) which is a compressed composite according to any one of claims 1 to 11.

13. The disposable diaper of claim 12 wherein said absorbent pad is comprised of two or more absorbent compressed composites (33, 34, 35).

14. The disposable diaper of claim 12, wherein in said composite first layer is sandwiched between two second layers.

15. A sanitary napkin comprising an absorbent structure partially encompassed by a liquid barrier (54) with a moisture-permeable overwrap (42), wherein the absorbent structure (55) comprises a compressed composite according to any one of claims 1 to 11.

16. The sanitary napkin of claim 15 wherein said absorbent structure comprises two compressed composites (53, 55) superimposed one upon the other with the absorbing layers (57, 59) immediately adjacent one another.

17. A tampon having as its adsorbent portion a compressed composite according to any one of claims 1 to 11.

18. The tampon of claim 17, wherein in said composite the first layer is sandwiched between two second layers.

19. A wipe comprising a compressed composite according to any one of claims 1 to 11.

20. A method for forming an absorbent compressed composite according to any one of claims 1 to 11 comprising;

forming a fibrous web;

interspersing therein superabsorbent material to form an absorbing layer;

contacting a wicking layer with one surface of said absorbing layer and compressing said layers sufficiently to reduce the thickness thereof by at least 50 percent.

Patentansprüche

1. Absorbierender, komprimierter Verbundkörper, umfassend:

—eine erste faserige Schicht (12), welche in der

nicht - komprimierten Form eine gegebene Dickenabmessung aufweist;

—ein wasserunlösliches, jedoch in Wasser quellbares, polymeres, superabsorbierendes Material (16), welches befähigt ist, Wasser in einer Menge zu absorbieren, welche wenigstens dem 10-fachen des Gewichtes der Substanz in ihrer trockenen Form entspricht, innerhalb der genannten ersten Schicht (12), und welches die genannte erste Schicht (12) in einer komprimierten Form mit einer Dickenabmessung erhält, welche geringer als die genannte, gegebene Dickenabmessung ist; und

—eine zweite Schicht (14) auf der genannten ersten Schicht (12), wobei sich Teile der genannten zweiten Schicht (14) in die genannte erste Schicht (12) hinein erstrecken und mit dieser Schicht (12) räumlich einstückig verbunden werden, um eine Übergangszone zu schaffen;

—wobei die genannte zweite Schicht (14) kein superabsorbierendes Material einverleibt enthält und dichter als die genannte erste Schicht (12) ist, bevor das superabsorbierende Material (16) der letztgenannten Schicht (12) einverleibt wird,

—wodurch Flüssigkeit, die auf den genannten Verbundkörpern auftrifft, einem rascheren dochtartigen Aufsaugen längs der Oberfläche der genannten zweiten Schicht (14) als längs der Oberfläche der genannten ersten Schicht (12) unterliegt, und wodurch auf den genannten Verbundkörper (10) auf einer gegebenen Fläche auftreffende Flüssigkeit in der genannten zweiten Schicht (14) von der genannten gegebenen Fläche weg befördert und auf Teile der genannten ersten Schicht (12) verteilt wird, die von der genannten gegebenen Fläche entfernt sind;

—und wobei das genannte superabsorbierende Material (16) beim Aufquellen sein Festhalten an der genannten ersten Schicht aufgibt, womit der genannten ersten Schicht (12) nach einer Absorption von Flüssigkeit in das genannte superabsorbierende Material (16) ein Expandieren aus der genannten komprimierten Form ermöglicht wird.

2. Komprimierter Verbundkörper nach Anspruch 1, worin:

—die erste Schicht (12) ein auf die Trockenmasse bezogenes Rückfederungsvermögen von wenigstens 30%, ein anfängliches Trockenschüttgewicht von wenigstens 20 cm^3/g, und ein Flächengewicht von weniger als 68 g/m^2 (2 Unzen je Quadratyard) aufweist;

—die zweite Schicht (14) Teilchen umfaßt, welche aus Zellulosefasern, Torfmoos, Reyonfasern oder Gemischen davon bestehen; und

—die Menge des vorliegenden superabsorbierenden Materials (16) wenigstens 200%, bezogen auf das Trockengewicht (nämlich bezogen auf das Trockengewicht der genannten ersten Bahn [12]), ausmacht.

3. Komprimierter Verbundkörper nach Anspruch 1 oder Anspruch 2, worin das superabsorbierende Material (16) als eine Meherzahl von Teilchen oder Kügelchen vorliegt.

4. Komprimierter Verbundkörper nach einem der Ansprüche 1 bis 3, worin das superabsorbierende Material (16) in einer Menge von 200 bis 1500%, bezogen auf das Trockengewicht, vorliegt.

5. Komprimierter Verbundkörper nach Anspruch 4, worin das superabsorbierende Material (16) in einer Menge von 400% bis 1200%, bezogen auf das Trockengewicht, vorliegt.

6. Komprimierter Verbundkörper nach einem der Ansprüche 1 bis 5, worin die genannte erste Schicht (12) eine Faservliesstoffbahn ist.

7. Komprimierter Verbundkörper nach Anspruch 6, worin die Bahn (12) aus synthetischen Stapelfasern aufgebaut ist.

8. Komprimierter Verbundkörper nach Anspruch 6 oder Anspruch 7, worin die Faservliesstoffbahn (12) aus Polyesterfasern aufgebaut ist.

9. Komprimierter Verbundkörper nach einem der Ansprüche 1 bis 8, worin die genannte zweite Schicht (14) aus chemisch delignifizierten Holzzellstoffasern besteht.

10. Komprimierter Verbundkörper nach einem der Ansprüche 1 bis 8, worin die genannte zweite Schicht (14) aus Torfmoos besteht.

11. Absorbierender Verbundkörper nach einem der Ansprüche 1 bis 8, worin die genannte zweite Schicht (14) aus Reyonfasern besteht.

12. Wegwerfwindel (30), welche ein absorbierendes Kissen (33) enthält, das ein komprimierter Verbundkörper nach einem der Ansprüche 1 bis 11 ist.

13. Wegwerfwindel nach Anspruch 12, worin das genannte absorbierende Kissen aus zweien oder mehreren absorbierenden, komprimierten Verbundkörpern (33, 34, 35) besteht.

14. Wegwerfwindel nach Anspruch 12, worin die genannte erste Schicht des Verbundkörpers zwischen zwei zweiten Schichten angeordnet ist.

15. Hygienische Binde, welche eine absorbierende Struktur umfaßt, welche teilweise von einer Flüssigkeitssperrschicht (54) mit einer feuchtigkeitsdurchlässigen Umhüllung (42) umgeben ist, wobei die absorbierende Struktur (55) einen komprimierten Verbundkörper nach einem der Ansprüche 1 bis 11 umfaßt.

16. Hygienische Binde nach Anspruch 15, worin die genannte absorbierende Struktur zwei komprimierte Verbundkörper (53, 55) umfaßt, welche derart übereinander gelegt sind, daß die absorbierenden Schichten (57, 59) direkt nebeneinander zu liegen kommen.

17. Tampon, dessen absorbierender Teil ein komprimierter Verbundkörper nach einem der Ansprüche 1 bis 11 ist.

18. Tampon nach Anspruch 17, worin die erste Schicht in dem genannten Verbundkörper zwischen zwei zweiten Schichten angeordnet ist.

19. Wischtuch, welches einen komprimierten Verbundkörper nach einem der Ansprüche 1 bis 11 umfaßt.

20. Verfahren zur Herstellung eines absorbierenden, komprimierten Verbundkörpers nach einem der Ansprüche 1 bis 11, welches die folgenden Stufen umfaßt:

—Ausbilden einer Faserbahn;

—Verteilen von superabsorbierendem Material in derselben unter Bildung einer absorbierenden Schicht;

—Inberührungbringen einer dochtartig aufsaugenden Schicht mit einer Oberfläche der genannten absorbierenden Schicht, und ausreichendes Komprimieren der genannten Schichten, um deren Dicke um wenigstens 50% zu verringern.

Revendications

1. Composite absorbant comprimé qui comprend:

une première couche fibreuse (12) ayant une épaisseur donnée à l'état non comprimé;

une matière polymère superabsorbante (16) insoluble dans l'eau mais gonflable par l'eau et qui est capable d'absorber de l'eau en une quantité qui est d'au moins dix fois son propre poids à l'état sec, en dedans de ladite première couche (12) et qui maintient ladite première couche (12) dans un état comprimé d'une dimension d'épaisseur plus faible que ladite épaisseur donnée; et

une seconde couche (14) sur ladite première couche (12), des parties de ladite seconde couche (14) débouchant dans ladite première couche (12) pour devenir solidaires dans l'espace avec elle pour ainsi établir une zone de transition;

ladite seconde couche (14) ne contenant pas de matière superabsorbante et étant plus dense que ladite première couche (12) avant l'incorporation de la matière superabsorbante (16) dans celle-ci,

de sorte que le liquide mouillant ledit composite progresse par un effet de mèche plus rapidement suivant la surface de ladite seconde couche (14) que le long de la surface de ladite première couche (12), et le liquide mouillant ledit composite (10) dans une zone donnée est transporté dans ladite seconde couche (14) à l'écart de ladite zone donnée et étant distribué à des portions de ladite première couche (12) éloignées de ladite zone donnée,

ladite matière superabsorbante (16), quand elle gonfle, libérant son contenu sur ladite première couche, pour ainsi permettre l'expansion de la première couche (12) à partir de sa forme comprimée lors de l'absorption du liquide dans ladite matière superabsorbante (16).

2. Composite comprimé selon la revendication 1, dans lequel:

la première couche (12) présente un rappel volumique à sec d'au moins 30%, un volume initial à sec d'au moins 20 cm^3/g et un poids inférieur à 68 $g.m^{-2}$ (2 $oz.yd^{-2}$);

la seconde couche (14) comprend des particules formées de fibres cellulosiques, de sphaignes, de fibres de rayonne ou de mélanges de celles-ci; et

la quantité de la matière superabsorbante (16) présente est d'au moins 200% du poids de base sec [par rapport au grammage sec de ladite première bande (12)].

3. Composite comprimé selon la revendication 1 ou 2, dans lequel la matière superabsorbante (16) est présente sous forme d'une série de particules ou globules.

4. Composite comprimé selon l'une quelconque des revendications 1 à 3, dans lequel la matière superabsorbante (16) est présente en une quantité de 200 à 1500% du grammage sec.

5. Composite comprimé selon la revendication 4, dans lequel ladite matière superabsorbante (16) est présente à raison de 400 à 1200% du grammage sec.

6. Composite comprimé selon l'une quelconque des revendications 1 à 5, dans lequel ladite première couche (12) est une nappe fibreuse non tissée.

7. Composite comprimé selon la revendication 6, dans lequel la nappe (12) est en fibres discontinues synthétiques.

8. Composite comprimé selon la revendication 6 ou 7, dans lequel la nappe non tissée (12) est en fibres du polyester.

9. Composite comprimé selon l'une quelconque des revendications 1 à 8, dans lequel ladite seconde couche (14) est en fibres de pâte de bois chimiquement délignifiée.

10. Composite comprimé selon l'une quelconque des revendication 1 à 8, dans lequel ladite seconde couche (14) est en sphaignes.

11. Composite absorbant selon l'une quelconque des revendication 1 à 8, dans lequel ladite seconde couche (14) est en fibres de rayonne.

12. Couche jetable (30) contenant un tampon absorbant (33) qui est un composite comprimé selon l'une quelconque des revendications 1 à 11.

13. Couche jetable selon la revendication (12) dans laquelle ledit tampon absorbant est constitué de deux ou plusieurs composites comprimés absorbants (33, 34, 35).

14. Couche jetable selon la revendication (12) dans lequel ladite première couche composite est en sandwich entre deux secondes couches.

15. Serviette hygiénique comprenant une structure absorbante partiellement délimitée par une barrière liquide (54) comportant une surcouche (42) perméable à l'humidité, dans laquelle la structure absorbante (55) comprend un composite comprimé selon l'une quelconque des revendications 1 à 11.

16. Serviette hygiénique selon la revendication 15, dans laquelle ladite structure absorbante comprend deux composites comprimés (53, 55) superposés l'un sur l'autre, les couches absorbantes (57, 59) étant immédiatement adjacentes l'une à l'autre.

17. Tampon dont la portion absorbante est un composite comprimé selon l'une quelconque des revendications 1 à 11.

18. Tampon selon la revendication 17, dans lequel la première couche dudit composite est en sandwiche entre deux secondes couches.

19. Torchon qui comprend un composite comprimé selon l'une quelconque des revendications 1 à 11.

20. Procédé de formation d'un composite absorbant comprimé selon l'une quelconque des

revendications 1 à 11, qui comprend les étapes consistant:

à former une nappe fibreuse;

à disperser dans celle-ci une matière super-absorbante pour former la couche absorbante;

à mettre en contact une couche à effet de mèche avec une surface de ladite surface absorbante et à comprimer lesdites couches suffisamment pour réduire leur épaisseur d'au moins 50%.

FIG-1

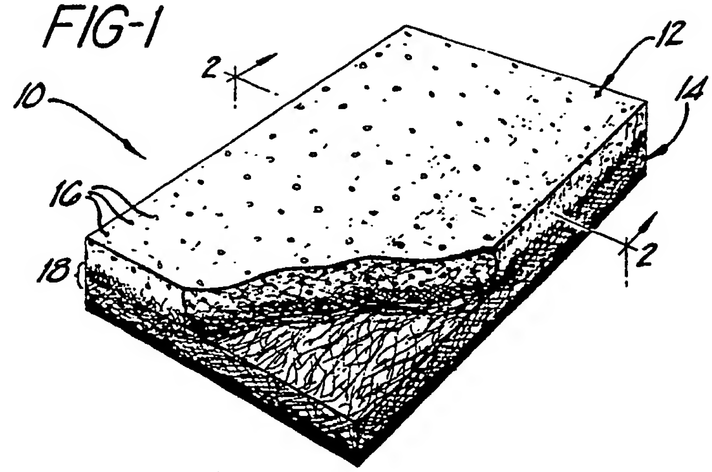


FIG-2

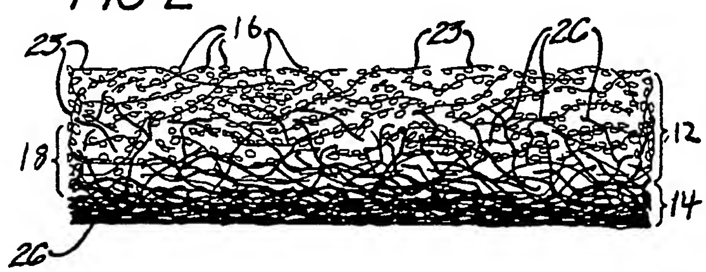


FIG-2A

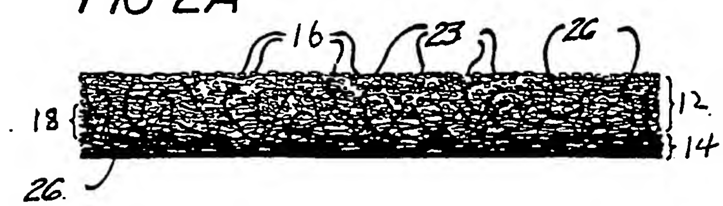


FIG-3

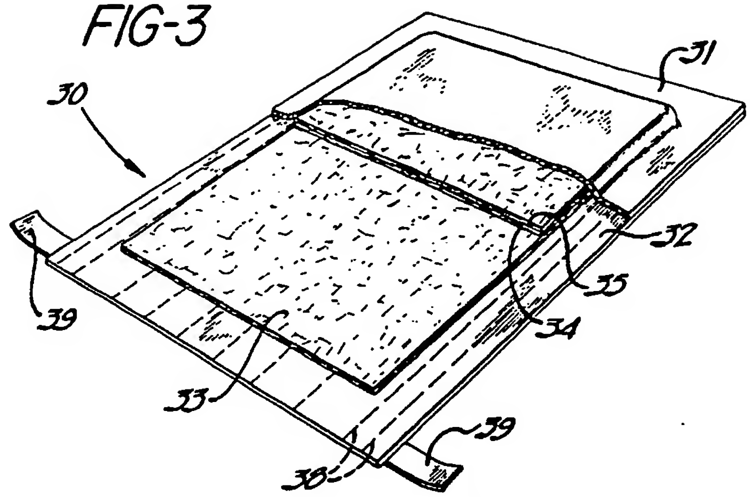


FIG-10

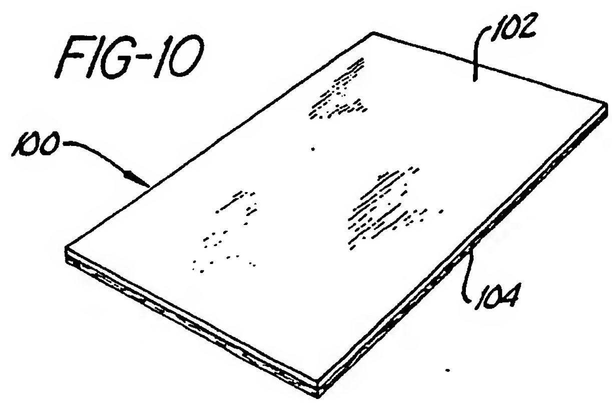


FIG-4

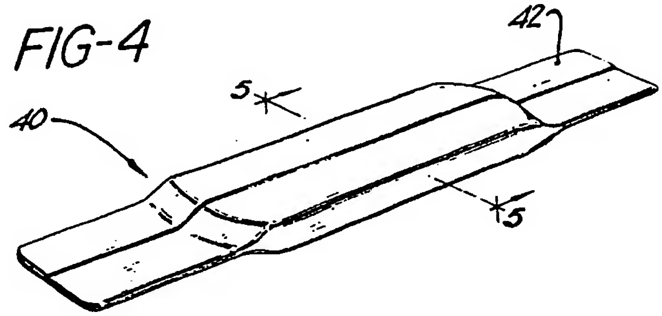


FIG-5

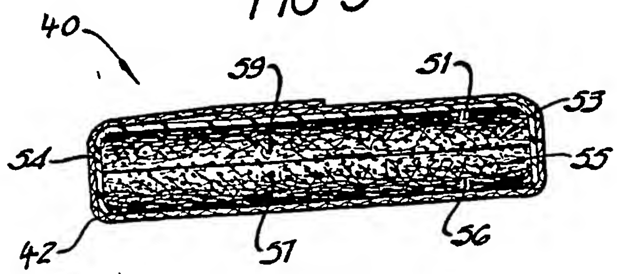
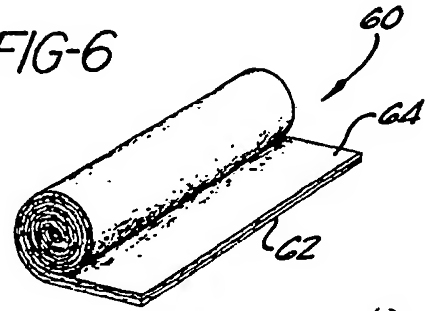


FIG-6



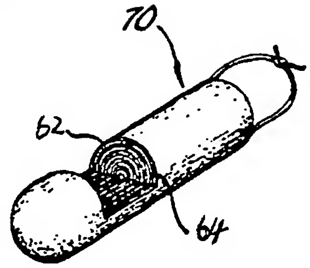


FIG-7

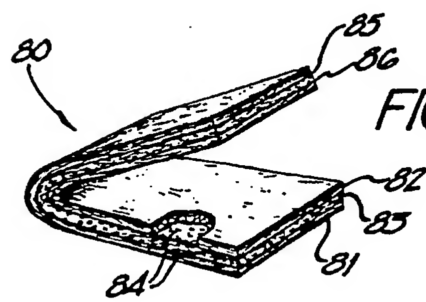


FIG-8

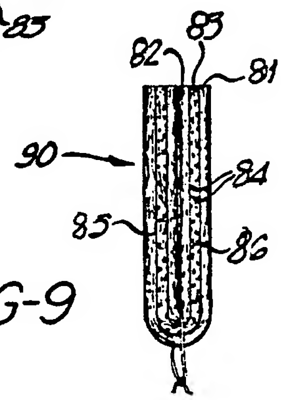


FIG-9